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MILITARY DIETARY REFERENCE INTAKES: RATIONALE FOR TABLED VALUES

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The military services periodically publish a joint regulation on nutrition allowances, standards, and education (more recently, Army Regulation 40-25, Naval Medical Command Instruction 10110.1, and Air Force Regulation 160-95). Summary tables in the regulation have presented the Military Recommended Dietary Allowances (MRDA). In FY01, a revised regulation (AR 40-25, NAVMEDCOMINST 10110.1/AFI 44-141), now entitled Nutrition Standards and Education, was published. The 2001 regulation now presents Military Dietary Reference Intakes (MDRIs), as well as Nutritional Standards for Operational and Restricted Rations (NSORs). This technical note traces the changes between the 1985 and 2001 regulations and documents the rationale used in establishing the MDRIs and NSORs.

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SYMBOLS, ABBREVIATIONS, AND ACRONYMS

α	Alpha
AI	Adequate Intake
AFR	Air Force Regulation
AR	Army Regulation
β	Beta
d	Day
def	Dietary Folate Equivalent
DHHS	U.S. Department of Health and Human Services
DoD	Department of Defense
DRI	Dietary Reference Intake
EAR	Estimated Average Requirement
EMR	Estimated Minimum Requirement
ESADDI	Estimated Safe and Adequate Daily Dietary Intake
FNB	Food and Nutrition Board
g	Gram
IOM	Institute of Medicine
IU	International Unit
kcal	Kilocalorie
kg	Kilogram
lb	Pound
LRP	Long Range Patrol, Food Packet
μg	Microgram
mg	Milligram
MCW	Meal, Cold Weather
MDRI	Military Dietary Reference Intake
MRDA	Military Recommended Dietary Allowances
MRE	Meal, Ready-to-Eat
NE	Niacin Equivalent
NGSR	New Generation Survival Ration
NRC	National Research Council
NSOR	Nutritional Standards for Operation Rations
RCW	Ration, Cold-Weather
RDAs	Recommended Dietary Allowances
RE	Retinol Equivalent
REE	Resting Energy Expenditure
RLW	Ration Light Weight
TE	Tocopherol Equivalent (obsolete)
UL	Tolerable Upper Intake Level
USDA	U.S. Department of Agriculture
yr	Year

FORWARD

Recognition should be given to the Assistant Army Medical Service Corps Chiefs (Dietetics)—COL Karen Fridlund, COL L. Susan Standage, COL Richard Lynch, and COL Margaret Applewhite—and the nutrition staff officers in the Office of the Army Surgeon General—MAJ Dale Hill, MAJ Sue Chiang, and LTC Vicky Thomas—who kept the arduous revision process moving toward an end.

At the time the 2001 Nutrition Standards and Education regulation and this supporting document were drafted and staffed, the Institute of Medicine of the National Research Council had not released the now published Dietary Reference Intakes (DRIs) for vitamin A, vitamin K, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, vanadium, and zinc. Therefore, the Military Dietary Reference Intakes for vitamins A and K, iodine, iron, and zinc presented in the 2001 regulation are based on the 1989 Recommended Dietary Allowances and there are no reference values presented for boron, chromium, copper, manganese, molybdenum, nickel, and vanadium. Incorporation into the regulation of recommended dietary reference intakes for these nutrients, as well as other nutrients for which DRIs are yet to be established, will be addressed in forthcoming updates to the regulation. Table A-3 in the Appendix presents the DRIs that have not been incorporated into the regulation.

INTRODUCTION

The military services periodically publish a joint regulation on nutrition allowances, standards, and education (more recently, Army Regulation 40-25, Naval Medical Command Instruction 10110.1, and Air Force Regulation 160-95) (6). Summary tables in the regulation have presented the Military Recommended Dietary Allowances (MRDA). The MRDAs traditionally have been based on the Recommended Dietary Allowances (RDA) of the Food and Nutrition Board (FNB), Institute of Medicine, National Academy of Sciences. The MRDA regulation also incorporated the principles of The Dietary Guidelines (23). In FY01, a revised regulation (AR 40-25, NAVMEDCOMINST 10110.1/AFI 44-141), now entitled Nutrition Standards and Education, was published (7). In the same way the 1985 regulation was usually referred to as "the MRDA regulation," the Nutrition Standards and Education regulation will be referred to as the MDRI regulation.

The version of the MRDA regulation immediately preceding the 2001 revision was published in 1985 and was based on the 1980 RDA publication (19). Since then, the FNB has published the 10th edition of the RDA (21) and has released the first three of a series of revisions of the RDA to present a conceptually new approach in setting and presenting nutrient recommendations (11–13). Unlike the RDAs, which established the amounts of nutrients needed to protect the American population against possible nutrient deficiencies, the new values, collectively termed Dietary Reference Intakes (DRIs), are designed to optimize the health of individuals.

The Department of Defense (DoD) Nutrition Committee decided that military dietary recommendations would continue to be based on the expert scientific opinion of the FNB. In so doing, nutrient recommendations for military personnel, formerly termed MRDAs, are now presented as Military Dietary Reference Intakes (MDRIs) in the latest revision of the Nutrition Standards and Education regulation. When the current regulation was finalized, the DRIs for calcium, phosphorus, magnesium, vitamin D, fluoride, thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, vitamin C, vitamin E, and selenium had been released (11–13) and were incorporated into the MDRIs. Although DRIs were released for pantothenic acid, biotin, and choline (12), MDRIs were not established for these nutrients because there is currently inadequate food composition data upon which to evaluate their adequacy in the diets of military personnel. Additional or revised MDRIs will be presented in interim changes to the regulation when DRIs are released or revised by the FNB, after considering military-specific issues.

Most of the changes in nutrient recommendations from the 1985 MRDA regulation to the 2001 MDRI regulation reflect changes from the 1980 to the 1989 RDAs and the subsequent DRIs. This Technical Note traces these changes and documents the rationale used in establishing the MDRIs.

DIETARY REFERENCE INTAKES

DRIs update and expand the RDAs. They are reference values that are quantitative estimates of nutrient intake to be used for planning and assessing diets for healthy people. Reference intakes are standards for nutrient intakes for use by health professionals, not recommendations for the public. To provide the general population with meaningful information about nutritionally adequate diets, it is necessary to express DRIs in terms of foods, not nutrients. For this reason, the Nutrition Standards and Education regulation stipulates that nutrition education messages, as well as military menus, will incorporate the principles of the Dietary Guidelines for Americans and the Food Guide Pyramid (23,27,29). DRIs include RDAs, but also three other types of reference values. The reference values and definitions of the terms, as defined by the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes are outlined below.

Estimated Average Requirement (EAR) is the intake of a nutrient that meets the estimated nutrient need of half the healthy individuals in a particular life-stage (life-stage considers age and, when applicable, pregnancy or lactation) and gender group. To establish an EAR, a specific functional endpoint or criterion is selected. For some nutrients, the criterion for the definition of recommended intakes has changed from the 1980 and 1989 RDA publications. For example, the criterion of adequacy of vitamin C used to establish the 1989 RDA for nonsmokers was the amount necessary to maintain a body pool of approximately 1500 mg, while the DRI for vitamin C was based on the level of intake sufficient to maintain near-maximal neutrophil concentrations with minimal urinary loss. The indicator of adequacy used to set an EAR (or Adequate Intake) may relate to the reduction of risk of chronic disease or disorder (such as osteoporosis, heart disease, or high blood pressure), whereas the 1980 and 1989 RDAs were based solely on traditional indicators of nutrient deficiency (for example, balance studies or circulating nutrient concentrations. The EAR is used as the basis for developing the RDA and is to be used by nutrition policy makers in the evaluation of the adequacy of nutrient intakes of the group and for planning how much, on average, the group should consume.

Recommended Dietary Allowance (RDA) is the average daily dietary intake level of a nutrient that is sufficient to meet the nutrient need of more than 95% of the healthy individuals in a particular life-stage and gender group. An RDA for a nutrient is based on the EAR, therefore, no RDA can be set if an EAR cannot be established. The RDA is defined as equal to the EAR plus twice an estimated coefficient of variation (10%–15%) or, if available, twice the standard deviation of the EAR.

The RDA for a nutrient is to be used as a goal for dietary intake by healthy individuals to decrease the risk of chronic disease. The RDA is not intended to be used to assess the diets of either individuals or groups or to plan diets for groups. Nevertheless, if an individual's average intake meets or exceeds an RDA, there is good assurance that intake of that nutrient is adequate, based on the functional criterion used to establish the EAR for that nutrient. However, if an individual's average intake over time is less than the RDA, there is some likelihood of inadequacy—the further intake falls below the RDA, the greater the likelihood.

Adequate Intake (AI) is the reference intake established when sufficient scientific evidence is not available to estimate an average requirement. The AI is an experimentally-determined or observed level of intake which appears to sustain a desired indicator of health (for example, calcium retention) for most members of a life-stage and gender group.

Tolerable Upper Intake Level (UL) is the highest level of daily intake of a nutrient by an individual that is unlikely to pose risks of adverse health effects in almost all healthy individuals in a specific population group. For most nutrients, this figure refers to total intake from food, fortified food, and supplements. As intake increases above the UL, the risk of adverse effects increases. For many nutrients, there may be insufficient data on which to develop a UL. This does not mean there is no potential for adverse effects from high intakes. When data on adverse effects are extremely limited, extra caution against taking excessive amounts of the nutrient may be warranted.

Estimated Safe and Adequate Daily Dietary Intakes are not DRI values but were presented in the 1989 RDA publication (21) and remain in effect for copper, manganese, chromium, and molybdenum. The FNB provided estimated safe and adequate intake ranges for essential nutrients when scientific data were sufficient to estimate a range of requirements, but insufficient to develop an RDA. Estimated safe and adequate intake ranges for select nutrients were presented in the 1985 regulation, but are not in the 2001 regulation because of uncertainty as to how to incorporate them into a regulatory format which required a single value recommendation. It is expected the remaining estimated safe and adequate daily dietary intakes will be replaced by DRIs in future publications of the FNB.

MILITARY DIETARY REFERENCE INTAKES

The DoD Nutrition Committee adopted the new concepts for establishing reference nutrient intakes of the FNB Committee on Scientific Evaluation of Dietary Reference Intakes. As a result, Military Dietary Reference Intakes (MDRIs) replace Military Recommended Dietary Allowances (MRDAs) in the revised tri-service regulation governing nutrition standards and education (7). Table 1 on page 4 presents the MDRIs. The Nutrition Standards And Education regulation does not present tolerable upper intake levels (UL), since these would not differ from the DRI publications for military individuals. The regulation will be periodically changed to incorporate new or revised DRIs as they are released by the FNB of the National Academy of Sciences.

The MDRIs are established for healthy, 17 to 50 year old, physically-active military men and non-lactating, non-pregnant women. This age group represents the majority of military personnel on active or reserve duty. Although there are personnel older than 50 years, and some of their nutrient needs differ from those for younger individuals, they compose only 0.5% of active-duty strength. For these individuals, the values presented in the DRI publications for ages 51 through 70 years are appropriate. The age range covered by MDRIs incorporates three of the age classes for which DRIs have been set (14 to 18, 19 to 30, and 31 to 50 years) and three of the age classes used in the 10th edition of the RDA (15 to 18, 19 to 24, and 25 to 50 years). Tables A1 and A2 in the Appendix present the values that were considered when establishing the MDRIs. For most nutrients, the MDRI (see Table 1 with footnotes) is the highest gender-specific reference value or RDA. However, the MDRIs for calcium, phosphorus, and iron for males and calcium, phosphorus, and magnesium for females, are not based on the highest reference intake or allowance, which is for 14 to 18 year old individuals. Only 2%–3% of the military population is 17 to 18 years old; thus, inflating the MDRIs to meet the needs of relatively so few individuals would not be warranted. Where research suggests that a nutrient requirement is affected by extremes in physical activity and/or environmental temperature, the reference intake was modified to accommodate the special requirements of military personnel under various operational conditions or additional guidance was provided in the regulation.

Although dietary allowances and reference intakes are expressed as quantities of a nutrient per day or daily intake, the terms *per day* or *daily* should be interpreted as average intake over time rather than intake each day. For most nutrients, MDRIs are intended to be average intakes over at least 3 days; for others (e.g., vitamins A and B12), they may be averaged over several months.

Table 1. Military Dietary Reference Intakes[1]

Nutrient	Unit	Men	Women
Energy[2] *General/Routine:*	*kcal*	*3250*	*2300*
Light activity	Kcal	3000	2200
Moderate activity	Kcal	3250	2300
Heavy activity	kcal	3950	2700
Exceptionally-heavy activity	kcal	4600	3150
Protein[3]	g	91 (63-119)	72 (50-93)
Vitamin A[4]	μg RE	1000	800
Vitamin D[5]	μg	5	5
Vitamin E[6]	mg	15	15
Vitamin K	μg	80	65
Vitamin C	mg	90	75
Thiamin (B_1)	mg	1.2	1.1
Riboflavin (B_2)	mg	1.3	1.1
Niacin[7]	mg NE	16	14
Vitamin B_6	mg	1.3	1.3
Folate[8]	μg DFE	400	400
Vitamin B_{12}	μg	2.4	2.4
Calcium[9]	mg	1000	1000
Phosphorus[10]	mg	700	700
Magnesium[11]	mg	420	320
Iron[12]	mg	10	15
Zinc	mg	15	12
Sodium[13]	mg	5000 (4550-5525)	3600 (3220-3910)
Iodine	μg	150	150
Selenium	μg	55	55
Fluoride[14]	mg	4.0	3.1
Potassium[15]	mg	3200	2500

[1] Values for energy, protein, and associated nutrients are based on moderate activity levels and reference body weights of 79 kg (174 lb) for military men and 62 kg (136 lbs) for military women.

[2] Energy recommendations for various activity levels are estimates only and vary among individuals. Persons weighing more than the reference military man or woman (approximately half of the military population) likely have higher energy requirements; persons weighing less than the reference military man or woman (approximately half of the military population) likely have lower energy requirements. The general values are for moderate levels of activity and are appropriate for most personnel in garrison. Values are rounded up to the nearest 50 kcal.

[3] The initial values in the table represent the midpoints of the ranges calculated using military reference body weights and protein intake recommendations of 0.8 to 1.5 g per kg body weight.

[4] The unit of measure is microgram Retinol Equivalent (μg RE). 1 μg RE = 1 μg retinol or 6 μg β-carotene. 1 μg RE = 10 International Units (IU) vitamin A if from β-carotene. 1 μg RE = 3.33 IU vitamin A if from retinol. NOTE: The total vitamin A content of a food expressed in IU cannot be directly converted to RE.

[5] As cholecalciferol. 1μg cholecalciferol = 40 IU vitamin D. In the absence of adequate exposure to sunlight.

[6] The unit of measure is milligram α-tocopherol that includes RRR-α-tocopherol (formerly termed d-α tocopherol, the natural form) and the 2R-stereoisomeric forms that are found in fortified foods and dietary supplements. This does not include the 2S-stereoisomeric forms that are also found in fortified foods and dietary supplements.

[7] The unit of measure is niacin equivalent (NE). 1 mg NE = 1 mg niacin or 60 mg dietary tryptophan.

[8] The unit of measure is Dietary Folate Equivalent (DFE). 1 μg DFE = 1.0 μg food folate, 0.5 synthetic folic acid taken on an empty stomach, or 0.6 μg synthetic folic acid taken with meals. Women capable of becoming pregnant should consume 400 μg of synthetic folic acid daily, from fortified foods or supplements or a combination of both, in addition to food folate.

[9] The MDRI for calcium will meet the needs of most personnel. However, personnel 17 to 18 years old have higher calcium needs not accounted for by this MDRI. A more appropriate dietary goal for personnel in this age group is 1300 mg/d. Special attention should be given to providing calcium-rich foods if serving meals to a group with a large proportion of military personnel younger than 19 years.

[10] The MDRI for phosphorus will meet the needs of most personnel. However, personnel 17 to 18 years old have higher phosphorus needs not accounted for by this MDRI. A more appropriate dietary goal for personnel in this age group is 1250 mg/d. Special attention should be given to providing phosphorus-rich foods if serving meals to a group with a large proportion of military personnel younger than 19 years.

[11] The MDRI for magnesium will meet the needs of most personnel. However, female personnel 17 to 18 years old have higher magnesium needs not accounted for by this MDRI. A more appropriate dietary goal for women in this age group is 360 mg/d. Special attention should be given to providing magnesium-rich foods if serving meals to a group with a large proportion of female personnel younger than 19 years.

[12] The MDRI for iron will meet the needs of most personnel. However, male personel 17 to 18 years old have higher iron needs not accounted for by this MDRI. A more appropriate dietary goal for men in this age group is 12 mg/d. However, meals that meet the MDRI for women will adequately supply the extra iron needs of men 17–18 years old.

[13] Sodium recommendations are based on 1400-1700 milligrams of sodium per 1000 kcal of energy consumed. The initial values in the table represent the midpoints of the ranges calculated using energy intakes for moderate activity of 3250 kcal for men and 2300 kcal for women.

[14] The MDRI is based on a recommended daily intake of 0.05 mg/kg body weight.

[15] The minimum requirement for potassium is approximately 1600-2000 mg/day. The MDRI is based on a recommended daily intake of 40 mg/kg body weight.

BASES OF MDRIs

Following is a summary of the rationale used to establish a MDRI for each nutrient in Table 1, as well as the basis for the guidelines for carbohydrate and fat that appear in the regulation. There is only one value for each gender-specific reference intake. This single value is appropriate for almost all military personnel. Because of constraints of the regulation format and to simplify the presentation and interpretation of the MDRIs, different values for different age groups, as was done for some nutrients in the 1985 MRDA regulation, are not presented in the table. Special considerations for specific age groups are conveyed in the table footnotes and the relevant summary paragraphs below. The data considered when establishing the MDRI are outlined in Tables A1 and

A2 in the Appendix. Complete details of the derivation and justification of the RDAs and DRIs can be found in the publications of the National Academy of Sciences (11–13, 21).

Reference Body Measures

Reference measures—in this case, weight and height—are the body measures that represent the average man or woman in a population. A reference individual is a hypothetical individual with these measurements. For the purposes of establishing MDRIs, the population considered is the active duty military population. The reference military man weighs 174 lb (79 kg) and is 69 inches (175 cm) tall. The reference military woman weighs 136 lb (62 kg) and is 64 inches (163 cm) tall.

The body weights selected to describe the reference military man and woman are the actual median weights (i.e., the 50th percentile) of military personnel as derived from the self-reported data of the 1995 Department of Defense Survey of Health Related Behaviors Among Military Personnel (R.M. Bray, personal communication, January 1998). These self-reported data agree with the 1988 U.S. Army Anthropometric Survey Database, after statistical adjustment to correct for demographic shifts in the Army between 1988 and 1996 (9). The reference body weights characterize the average service man and woman and are not recommended or ideal body weights.

Energy

Unlike the MDRI for other nutrients, the MDRIs for energy do not include a margin of safety to account for the needs of almost all military persons. Rather, the MDRIs for energy represent *average* needs of male and female individuals of reference body weights, thus reflecting estimated *average* energy requirements for the male and female military populations. Thus, potentially half of military men and women have energy requirements higher or lower than their MDRI. Using average needs of reference individuals to set the MDRIs for energy follows the basis of the RDA, which does not include an additional allowance to cover individual variation because of the concern that doing so could promote obesity (a greater public health problem than chronic energy deficits) in persons with average requirements.

The MDRIs for energy represent average needs of male and female individuals of reference body weights. The energy values are for military personnel performing varying levels of physical activities and living in a temperate climate or in a thermal-neutral environment. The MDRIs for energy are based on figures presented in the 10th edition of the RDA (21), table 3-4, page 29, for four levels of physical activity for ages 19 to 50 years. The estimated energy expenditures for men and women are presented in Table 2.

Table 2. Estimated Energy Expenditures (Kcal/kg/day)

Level of Activity	Men	Women
Light	38	35
Moderate	41	37
Heavy	50	44
Exceptional	58	51

Based on the military reference man of 79 kg (174 lb) and the military reference woman of 62 kg (136 lb), and rounding to the nearest 50 kcal, these figures translate to estimated average energy allowances, which are outlined in Table 3.

Table 3. Estimated Average Energy Allowances (kcal/day)

Level of Activity	Men	Women
Light	3000	2200
Moderate	3250	2300
Heavy	3950	2700
Exceptional	4600	3150

The energy recommendations for the different activity levels are intended for use as estimates only and will vary among individuals. Men or women weighing more than the reference military man or woman will have slightly higher average energy needs. Smaller individuals will require less energy than the MDRIs for energy. Body weight may be used as a basis for proportionately adjusting energy allowances for individuals with body sizes different from the reference individual, provided the individuals are not appreciably over or under the median weight for their given gender group. Although energy requirements gradually decline with age (beginning in adulthood) due to a reduction in resting metabolic rate and curtailment in physical activity, age-related differences in energy expenditures within the 17 to 50 year old military population appear to be minimal as long as similar levels of physical activity are maintained (21). The general/routine reference intake figures in Table 1 pertain to reference individuals with moderate levels of physical activity.

Macronutrients

Carbohydrate. There is no specific MDRI for carbohydrate because there is currently no RDA for carbohydrate. The guideline in the regulation is based on the recommendation in the 10th edition of the RDA (21) that at least half of the energy requirement be provided by carbohydrates. This is similar to the recommendation of the Committee on Diet and Health (20) for healthy adults to increase their carbohydrate intake to more than 55% of total calories by eating more carbohydrate-containing foods, with an emphasis on complex carbohydrates rather than added sugars. These proportional levels of carbohydrate intake equate to absolute intakes of about 400 grams and 300 grams for the reference man and woman, respectively, at moderate levels of activity. The Standing Committee on the Scientific Evaluation of Dietary Reference Intakes of the FNB will address the issues of energy and the macronutrients (specifically carbohydrate and fat) in a future report.

Protein. The MDRIs for protein are based on the 1989 RDA and the expanding body of sports nutrition science which indicates that during periods of heavy physical training, protein requirements are higher than the RDA to maintain nitrogen balance and increase muscle mass. The protein MDRIs are presented as a range (shown in parentheses) of 0.8 to 1.5 g/kg for the reference military man and woman. The lower value (0.8 g/kg) is the 1989 RDA (21) for dietary protein. The higher value in the range (1.5 g/kg) provides for the needs of individuals engaged in regular, intense physical training. The recommended range of protein intakes to meet the demands of physical training varies with the type of athlete, but recent recommendations based on the scientific literature range from 1.2 to 1.7 grams per kilogram body weight (14, 22, 25, 30) for most strength and endurance activities. The single value protein reference intake represents the midpoint of the range and is an appropriate intake goal for typical, physically-active military personnel. The MDRI for protein is easily met when energy intake is adequate and dietary protein supplies 10% to 15% of total energy intake.

The slight reductions in the protein MDRIs from the 1985 MRDA are due to the different methods used to derive them. The previous regulation based the protein allowance solely on the 1980 RDA (also 0.8 g/kg body weight) and the arbitrary reference body weights used in that edition of the RDA (19), 60–79 kg and 46–63 kg for males and females, respectively, depending on age (which included the age category 11–14 years). The mean of the resulting protein allowance range was then "approximately doubled to reflect the usual protein consumption levels of Americans and to enhance diet acceptability" (6). Although the MDRIs in the current regulation have not been inflated to comply with typical intakes, the new recommendations are only nine and ten percent lower than those in the previous regulation. The reference weights used for the 2001 MDRIs are actual medians of military personnel, 79 kg and 62 kg for men and women, respectively. In addition, the adjustment of the RDA to provide for the high levels of physical activity common in many military groups brings the reference intakes closer to, but not up to, the levels recommended in the 1985 MRDAs.

Fat. There is no MDRI for fat. The guideline in the regulation is based on the recommendation of the Committee on Diet and Health (20) that the fat content of the

U.S. diet not exceed 30% of energy intake, that less than 10% of calories should be provided from saturated fat, and that dietary cholesterol should be less than 300 mg/day. These recommendations provide quantitative targets that agree with the Dietary Guidelines for Americans (29). These guidelines are applicable to personnel in a garrison; however, operational and restricted rations may need a higher fat content in order to increase the energy density of the ration without detrimentally increasing the weight of the ration.

Vitamins

Vitamin A. The MDRIs of 1000 and 800 μg retinol equivalents (μg RE) for men and women, respectively, are based on the 1989 RDAs (21) that apply to 17 to 50 year old individuals. One μgRE = 1 μg retinol, 6 μg β-carotene, or 12 μg other provitamin A carotenoids. NOTE: The total vitamin A content of a food expressed in IU cannot be directly converted to RE. The vitamin A recommendations have not changed from the 1985 MRDA.

Vitamin D. The MDRIs for vitamin D are based on the AIs (5 μg cholecalciferol) established for the age ranges that include 17 to 50 year old men and women (11) and apply when there is an absence of adequate exposure to sunlight. Dietary intake of vitamin D is unnecessary for individuals who spend adequate amounts of time in the sun. However, an increase in skin melanin pigmentation, the topical application of a sunscreen, or the increase in the angle of the sun during some seasons or at northern latitudes will significantly reduce the production of vitamin D_3 in the skin (10) and, therefore, increase the need for a dietary source. The MDRI for vitamin D remains the same as the 1985 MRDA for 19 to 50 year old individuals; however, there is no longer a higher recommendation (10 μg) for individuals 17 to 18 years old. One μg cholecalciferol = 40 IU vitamin D.

Vitamin E. The MDRIs of 15 mg alpha (α) tocopherol for both men and women are based on the 2000 DRI RDAs (13) for adult men and women as well as those for boys and girls 14 to 18 years old. The RDAs of 15 mg/day of α-tocopherol were, in turn, based on EARs for these age groups of 12 mg/day.

The RDA is now based only on the α-tocopherol form of vitamin E. This represents a change from previous RDAs, to include the one on which the 1985 MRDA was based: Earlier recommendations considered all forms of vitamin E—the naturally-occurring tocopherols and tocotrienols, as well as all eight stereoisomers in the synthetic form—bioactive and presented values in α-tocopherol equivalents (α-TE). It is now known the different forms of "vitamin E" are not interconvertible and the 2R-stereoisomeric forms of α-tocopherol are the only forms of vitamin E that function to meet the vitamin E requirements in humans. The 2S-stereoisomeric forms of α-tocopherol and the other tocopherols (beta-, delta-, and gamma-tocopherol) and the tocotrienols are no longer considered to have vitamin E activity.

Natural vitamin E (found in food and natural supplements) is RRR-α-tocopherol, historically and incorrectly labeled "d-alpha-tocopherol." Synthetic vitamin E, used in

many supplements and for food fortification, is *all rac*-(racemic) α-tocopherol, often incorrectly labeled "*d,l*-alpha-tocopherol." Only half of the synthetic form is maintained in human plasma. Thus, the natural form is twice as bioactive as the synthetic form.

Currently, most nutrient databases, as well as nutrition labels, report α-tocopherol equivalents (α-TE) or international units (IUs) and combine the supposed contribution of all the tocopherols, after "adjusting" for the bioavailability of the various forms. Therefore, dietary intake expressed in α-TE is higher than the intake of α-tocopherol alone. The DRI publication (13) suggests estimating α-tocopherol by multiplying total α-TE in food by 0.8. However, vitamin E added as a food fortifier is a synthetic form, of which only half is bioavailable. Therefore, the conversion factor for synthetic vitamin E in fortified foods is 0.5.

Conversion of international units (IUs) to milligrams α-tocopherol depends on the form of the vitamin E in the supplement or fortified food. If the form is "natural" or RRR-α-tocopherol (likely labeled d-alpha-tocopherol), multiply the number of IUs by 0.67 to calculate the number of milligrams of α-tocopherol. If the form of vitamin E is *all rac*-α-tocopherol (likely incorrectly labeled *dl*- α-tocopherol), the appropriate multiplier is 0.45. The same factors are used if the α-tocopherol is esterified with succinate or acetate because the IU value already accounts for the differing molecular weights.

Although new scientific studies suggest vitamin E may help lower the risk of chronic conditions, such as heart disease and diabetes, the Panel on Dietary Antoxidants and Related Compounds felt that the limited and conflicting data warranted a deferral of any recommendation of higher vitamin E intakes (13).

Vitamin K. The MDRIs for vitamin K (80 and 65 μg for men and women, respectively) are based on the 1989 RDA (20) for the 25 to 50 year age group, which is the highest RDA for an age group encompassing the military population. The change in vitamin K recommendations from the 1985 MRDAs reflects the difference between the estimated safe and adequate dietary intake range presented in the1980 RDA publication, on which the 1985 MRDA was based, and the 1989 RDA, on which the current MDRI is based.

Vitamin C. The MDRI for vitamin C (ascorbic acid) is 90 mg/day for men and 75 mg/day for women. These values are based on the 2000 DRI RDAs (13) for persons aged 19 to 50 years. The EARs for vitamin C are 75 mg and 60 mg for adult men and women, respectively. The change from the 1985 MRDAs of 60 mg for both men and women reflects the change from using the amount of dietary vitamin C needed to maintain an ascorbate body pool of 1500 mg as the basis for establishment of the 1980 RDA to the use of the intake level that should maintain near maximal neutrophil ascorbate concentrations with little urinary excretion as the indicator of adequacy in the 2000 DRI RDA. The RDAs and, therefore the MDRIs, are now different for men and women because of consideration of women's smaller lean body mass. Because smoking increases oxidative stress and the metabolic turnover of ascorbate, the vitamin C recommendation for smokers is increased by 35 mg of vitamin C daily.

Thiamin (B_1). The 2001 MDRIs for thiamin (1.2 mg/day and 1.1 mg/day for men and women, respectively) are based on the 1998 DRI RDAs (12) for adult men and women. The EARs for thiamin are 1.0 mg/day for men and 0.9 mg/day for women. The MDRIs for thiamin are lower than the 1985 MRDAs because the dietary intake recommendations are no longer directly based on energy intake. The expert Panel on Folate, Other B Vitamins, and Choline of the DRI Committee found little evidence to support expressing thiamin requirements in relation to energy instead of on absolute terms. The Panel did, however, assume that average thiamin requirements of men and women differ slightly (ten percent) because of general differences in body size and energy utilization. Under most conditions, physical activity does not seem to substantially influence thiamin requirements; however personnel in physically demanding occupations or who spend a great deal of time training for active sports may require additional thiamin.

Riboflavin (B_2). The 2001 MDRIs for riboflavin (1.3 mg/day for men and 1.1 mg/day for women) are based on the 1998 DRI RDAs (12) for adult men and women. The EARs for riboflavin are 1.1 mg/day for men and 0.9 mg/day for women. The MDRIs for riboflavin are lower than the 1985 MRDAs because the dietary intake recommendations are no longer directly based on energy intake. However, because of the known biochemical function of riboflavin in the utilization of energy, the modestly different MDRIs for men and women reflect the small adjustment in the DRIs to account for general differences in body size and energy expenditure of men and women. Nevertheless, despite the role of riboflavin in energy metabolism, the expert Panel on B vitamins concluded that, although riboflavin requirements may well be increased in those who are ordinarily very physically active (e.g., athletes or those who carry heavy packs much of the day), the "data are not available on which to quantify the adjustment that should be made."

Niacin. The 2001 MDRIs for niacin (16 mg/day and 14 mg/day of niacin equivalents (NE) for men and women, respectively) are based on the 1998 DRI RDA (12) for adults 19 years and older. The EARs for niacin are 12 mg NE/day for men and 11 mg NE/day for women. The expression of niacin recommendations in niacin equivalents accounts for the potential conversion of the amino acid tryptophan to niacin. On average, 60 mg tryptophan equals 1 mg niacin.

The MDRIs for niacin are lower than the 1985 MRDAs because the dietary intake recommendations are no longer directly based on energy intake. However, because of the known biochemical function of niacin in the oxidation of fuel molecules, the modestly different MDRIs for men and women are due to the small adjustment (ten percent) in the EARs (reflected in the RDAs) to account for average differences in body size and energy expenditure of men and women.

Vitamin B_6. Vitamin B_6 refers to pyridoxine and related compounds. The 2001 MDRIs for vitamin B_6 (1.3 mg/day for both men and women) are based on the 1998 DRI RDAs (12) for 19–50 year old men and women. The EARs are 1.1 mg/day for both genders. The MDRIs for vitamin B_6 are much lower than the 1985 MRDAs because the dietary intake recommendations are no longer directly related to typically-generous

protein intakes. (The 1985 MRDAs of 2.2 mg for men and 2.0 mg for women were taken from the 1980 RDA, which based the allowance on 0.020 mg/g protein. The protein figures used in the derivation of the 1980 RDAs were the actual, average protein intake values reported by contemporary national food consumption surveys.)

Folate. The 2001 folate MDRI for men and women is 400 μg/day of dietary folate equivalents (DFEs). This value is based on the 1998 DRI RDA (12) for adults aged19 through 50 years. The RDA for individuals 17–18 years old is also 400 μg/day DFE. These RDAs are based on EARs of 320 μg/day of DFEs. To reduce the risk of neural tube defects in fetuses and children, women capable of becoming pregnant should consume 400 μg of folic acid daily from supplements, fortified foods, or both in addition to consuming food folate from a varied diet.

Although the MDRI value is the same as the 1985 MRDA, the rationale for the value and the unit of measure have changed. The 1980 RDA, on which the 1985 MRDA was based, established a level of folate intake adequate for the maintenance of tissue reserves. The 1998 DRI is based on the amount of DFEs needed to maintain erythrocyte folate with consideration of serum homocysteine and plasma folate levels. Expression of folate intake recommendations is now made in DFEs to adjust for the nearly 50% lower bioavailability of food folate compared to folic acid: 1 μg DFE = 1 μg food folate = 0.6 μg folic acid from fortified food or as a supplement consumed with food = 0.5 μg synthetic folic acid taken on an empty stomach.

Vitamin B_{12}. The MDRI for vitamin B_{12} (cobalamin) in the 2001 Nutrition Standards and Education regulation is based on the 1998 DRI RDA (12) of 2.4 μg for men and women. The EAR is 2.0 μg/day for both men and women. The 2001 MDRI value is twenty percent lower than the 1985 MRDA, which was based on the 1980 RDA. The reduction in RDA was based on more recent data suggesting that lower levels adequately maintain hematologic status and serum B_{12} values.

Minerals

Calcium. The 2001 MDRI for calcium is 1000 mg for both men and women. This is based on the AI level established by the 1997 DRIs (11) for individuals 19 to 50 years of age. The higher AI of 1300 mg for 17 to18 year old individuals was not used in setting the MDRI because personnel within this age group represent less than 3% of the military population (See tables A1 and A2 for gender-specific figures). However, special attention should be given to promoting the consumption of calcium-rich foods if serving meals to a group with a large proportion of military personnel younger than 19 years (i.e., during initial entry training). The 200 mg increase in calcium recommendations from the 1985 MRDA for 19 to 50 year old personnel reflects the change from the 1980 RDAs to the 1997 DRIs. The new calcium recommendations were set at levels associated with desirable retention of body calcium or the maintenance of minimal calcium losses.

Phosphorus. The 2001 MDRI for phosphorus is 700 mg for men and women. This value is based on the 1997 DRI RDA (11) for men and women aged 19 to 50 years. Different from the 1980 RDA upon which the 1985 MRDAs were based, the current RDA for phosphorus is no longer derived in relation to calcium. Serum inorganic phosphorus is the indicator now used for estimating the phosphorus requirement. Seven hundred milligrams phosphorus is considered sufficient to support normal bone growth and metabolism at ages 19 to 50 years. The phosphorus RDA for individuals aged 17 through 18 years is 1250 mg. Because personnel within this age group represent less than 3% of the military population, the higher RDA figure was not used when establishing the MDRI (see Tables A1 and A2 for gender-specific figures). However, special attention should be given to promoting the intake of phosphorus-rich foods if serving meals to a group with a large proportion of military personnel younger than 19 years (i.e., during initial entry training).

Magnesium. The magnesium MDRIs are 420 mg and 320 mg for men and women, respectively. These values are based on the RDAs in the 1997 DRIs (11) for 31 to 50 year old men and women, which are the higher of the RDAs for military-aged adults. The higher values were used to establish the MDRIs to meet the needs of almost all of the military population. The EARs for this same age group are 350 mg and 265 mg for men and women, respectively. Although the magnesium RDA for 17 to 18 year old women is 360 mg, women in this age group are only approximately 3.5% of the female active-duty population (See Table A2). Therefore, any further increase to the MDRI for women is not warranted. However, special attention should be given to promoting the consumption of magnesium-rich foods if serving meals to a group with a large proportion of female personnel younger than 19 years (i.e., during initial entry training).

Iron. The MDRI for iron is 10 mg for men and 15 mg for women. These values are based on the 1989 RDA (21), which kept the allowance for men as in the 1980 RDA (15), but reduced the allowance for adolescent and adult, pre-menopausal women from 18 mg/day to 15 mg/day. Although the RDA of 12 mg for 17-18 year old men is the highest RDA for the male age groups covered in the MDRI regulation, the MDRI was not based on this value because 17 to 18 year old men represent only 2.6% of active-duty men (See table A1). Male personnel aged 17 to 18 years should be encouraged to consume additional iron-rich foods to meet their RDA of 12 mg. Diets or food plans that meet the MDRI for women will be adequate for all male personnel.

Zinc. The MDRI for zinc is 15 mg for men and 12 mg for women. These values are based on the 1989 RDA (21), which kept the allowance for men as in the 1980 RDA (15), but reduced the allowance for women on the basis of their lower body weight. Therefore, the MDRI for zinc for women is lower than their 1985 MRDA.

Sodium. There is no DRI or RDA for sodium. The estimated minimum requirement for sodium is only 500 mg/d in a temperate environment (21). Even so, intakes this low are not necessary and are nearly impossible to achieve in a Western diet. The Committee on Diet and Health of the Food and Nutrition Board (20)

recommended that daily intakes of sodium chloride be limited to 6 grams (2400 mg of sodium) or less. However, the Committee on Military Nutrition Research considered the Diet and Health recommendation for the general population to be too low for military purposes (4). This is due to the potential risk of producing sodium depletion under some conditions, particularly in hot environments without adequate periods of adaptation. Nevertheless, because of the link between sodium and high blood pressure, excessive use of high-sodium products should be discouraged.

Sodium recommendations remain 1400–1700 mg/1000 kcal consumed. The ranges presented in the summary table were calculated using the energy MDRI for moderate activity (3250 kcal for men and 2300 kcal for women). The single values preceding the ranges (5000 mg/day for men and 3600 mg/day for women) are the midpoints of the ranges, rounded to the nearest 100 mg, and would be reasonable dietary targets for most garrison situations. The footnote to Table 2-1 in the regulation incorrectly states that the sodium recommendations are for the sodium content of food served. Table 2-1 in the regulation summarizes dietary intake recommendations, not menu standards.

Iodine. The MDRI for iodine is based on the 1989 RDA (21) of 150 μg daily for men and women aged 17 to 50 years. The recommendation remains the same as in the 1985 MRDA. Furthermore, the use of iodized salt at the table and in cooking is still recommended.

Selenium. The selenium MDRIs are 55 μg for men and women. These values are based on the 2000 DRI RDAs (13) for individuals 19 to 50 years of age. The 2000 DRI RDA is based on an EAR of 45 μg/day for adults at the male reference weights. The DRIs were based on male reference weights because women apparently are more susceptible to Keshan disease (the only human disease firmly linked to selenium deficiency) than men but most of the data used to set an EAR came from men. Because an RDA for selenium was established for the first time in 1989 (21), there was no MRDA for selenium in the 1985 regulation. However, the 1985 regulation did present the estimated safe and adequate intake range of 50–200 μg/day from the 1980 RDA publication (19), which is consistent with the current DRIs.

Fluoride. The MDRIs for fluoride, which include both food sources and drinking water, are 4.0 mg for men and 3.1 mg for women. The new recommendations are based on the 1997 AI for fluoride from all sources of 0.05 mg/kg/day (11) and reference weights for military men and women of 79 kg and 62 kg, respectively. The resultant values were rounded to the nearest tenth of a milligram, as done in the text of the 1997 DRI publication, instead of the nearest whole milligram, as presented in the summary table of the DRI publication (11). Fluoride recommendations in the 1985 regulation were presented as an estimated range of safe and adequate daily intakes (1.5 to 4.0 mg/day) per the 1980 RDA (19). Water fluoridation at a concentration of about 0.7 to 1.2 mg/liter (average ~1 part per million) is a very important method to help ensure adequate fluoride intakes for the promotion of dental health.

Potassium. There is no DRI for potassium. The estimated daily adult minimum requirement for potassium is 1600 to 2000 mg (21). However, there is considerable evidence that higher intakes of potassium are protective against hypertension and stroke. The MDRI for potassium was conservatively set at 1mmol/kg body weight, based on the recommendation of Luft (15). Based on reference weights of military men and women of 79 kg and 62 kg, respectively, and 40 mg per mmol potassium, the MDRIs were set at 3200 mg for men and 2500 mg for women. One mmol/kg agrees with the interpretation of the findings of the INTERSALT (INTERnational study of SALT and other electrolytes and blood pressure) study made by Stamler and colleagues (24). They determined that a population average daily potassium intake of 70 mmol is an achievable goal that could reduce the incidence of hypertension. This level of intake equates to 1 mmol/kg for a 70 kg reference individual, the reference body size typically used to describe an arbitrary ideal man.

The potassium MDRIs are in keeping with Canadian recommendations (2) for individuals to consume at least 60 mmol of dietary potassium. The United States Diet and Health Committee's recommendation (20) to consume five or more servings of a combination of fruits and vegetables every day would bring the potassium intake of adults to about 3500 mg per day. This level coincides with the more recent recommendation of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure of the National Institutes of Health (18) to consume at least 90 mmol or 3500 mg of potassium daily to prevent and control hypertension.

NUTRITIONAL STANDARDS FOR OPERATIONAL AND RESTRICTED RATIONS

Operational and restricted rations are designed to support military operations in the field in a wide variety of settings and situations. They are intended to provide the total food supply for potentially prolonged time periods. Operational rations are intended to be nutritionally complete and are acceptable for long-term consumption. Restricted rations are nutritionally-incomplete rations for use for periods of no more than 10 days, when logistical and mission considerations outweigh nutritional concerns.

Nutritional standards for operational rations (NSOR) and nutritional standards for restricted rations (Table 4, page 17) are for use by ration planners in the development and procurement of individual and group field rations. They are neither dietary reference intakes nor allowances; rather, they are criteria for what should be in the ration. The NSORs currently apply to the Meal, Ready-to-Eat (MRE); the Meal, Cold Weather (MCW); B rations; Tray Pack rations (heat and serve); and the Unitized Group Ration (A, B, or Heat and Serve). The standards for restricted rations currently apply to the Food Packet, Long Range Patrol (LRP) and will apply to the combined Meal, Cold Weather/Food Packet, Long Range Patrol (MCW/LRP) when issued at one meal bag per day. NSORs do not apply to survival rations, which are strictly for short-term situations.

The NSORs are derived from the MDRIs. They are, except for fat and sodium, minimum content standards at the time of consumption. The ration standards have not been upwardly adjusted to compensate for storage losses, nor do they take into account varying bioavailabilities of different forms of a nutrient—an exception being folate, which specifies content in dietary folate equivalents. It is important ration planners and manufacturers, when establishing product formulations, compensate for the losses of nutrients (such as ascorbic acid, thiamin, riboflavin, niacin, and vitamin B_6) which may occur during storage (up to three years) of operational and restricted rations.

NUTRITIONAL STANDARDS FOR OPERATIONAL RATIONS (NSOR)

The NSORs are prescriptions for the nutrient contents of operational rations. The NSORs are minimal levels of select nutrients which must be provided in order to promote adequate nutritional intakes by most, but not all, military personnel engaged in moderate to heavy physical activity in the field. Table 4 summarizes the NSORs. The bases of the standards follow the table.

Operational rations are to be designed so that either the average daily menu meets the NSOR (for menu-based rations) or the average meal meets one-third of the NSOR (for meal-based rations). No single meal menu should be less than 20% below one-third the NSOR for standards that are minimums, nor 20% above one-third the NSOR for standards that are maximums.

Table 4. Nutritional Standards for Operational and Restricted Rations (NSOR)[1]

Nutrient	Unit	Operational Rations	Restricted Rations
Energy	kcal	3600	1500
Protein	g	91	50
Carbohydrate	g	494	200
Fat	g	—[2]	—[2]
Vitamin A[3]	μg RE	1000	500
Vitamin D[4]	μg	5	3
Vitamin E[5]	mg	15	8
Vitamin K	μg	80	40
Vitamin C	mg	90	45
Thiamin (B_1)	mg	1.2	0.6
Riboflavin (B_2)	mg	1.3	0.7
Niacin[6]	mg NE	16	8
Vitamin B_6	mg	1.3	0.7
Folic Acid[7]	μg	400	200
Vitamin B_{12}	μg	2.4	1.0
Calcium	mg	1000	500
Phosphorus	mg	700	350
Magnesium	mg	420	210
Iron	mg	15	8
Zinc	mg	15	8
Sodium[8]	mg	5000–7000	2500–3500
Iodine	μg	150	75
Selenium	μg	55	28
Fluoride	mg	4.0	2.0
Potassium	mg	3200	2000

[1] Values are minimum standards at the time of consumption unless shown as a maximum level. Nutritional standards for rations are based on the MDRIs established for healthy, active military personnel of reference body size.

[2] Total energy from fat should not exceed 35% of total calories.

[3] The unit of measure is microgram retinol equivalent (μg RE). 1 μg RE = 1 μg retinol or 6 μg β-carotene. 1 μg RE = 10 International Units (IU) vitamin A if from β-carotene. 1 μg RE = 3.33 IU vitamin A if from retinol. NOTE: The total vitamin A content of a food expressed in IU cannot be directly converted to RE.

[4] As cholecalciferol. 1μg cholecalciferol = 40 IU vitamin D.

[5] The unit of measure is milligram α-tocopherol that includes RRR-α-tocopherol, the only form of α-tocopherol that is found in food, and the 2R-stereoisomeric forms that are found in fortified foods and dietary supplements. This does not include the 2S-stereoisomeric forms that are also found in fortified foods and dietary supplements.

[6] The unit of measure is niacin equivalent (NE). 1 mg NE = 1 mg niacin or 60 mg dietary tryptophan.

[7] The unit of measure is dietary folate equivalent (DFE). 1μg food folate, 0.5 μg synthetic folic acid acid taken on an empty stomach (not applicable to ration content standards), or 0.6 μg synthetic folic acid taken with meals.

[8] These values do not include the salt packet. The sodium content of restricted rations may not be adequate for military personnel operating in hot environments, especially if they are not acclimatized. In these situations, an electrolyte beverage may be indicated to provide additional electrolytes.

BASES OF RATION STANDARDS

For most nutrients, the ration standard is the higher of the two gender-specific MDRIs (see Table 1) to provide for the individuals with the higher needs. Exceptions to this rationale are discussed in the select comments that follow.

Energy

The energy standard of 3600 kcal is the average of the MDRIs for energy for moderate and heavy activity levels for male personnel. The energy standard in the 2001 and the 1985 regulations are the same, however different methods were used to derive them. The 1985 energy standard was set at the upper end of the energy MRDA range (2800-3600 kcal), which was estimated to reflect the requirements of 70% of the moderately-active military population. The current energy allowance estimate was calculated from a formula presented in the 1989 RDA: 1.7 x REE ± 400 kcal, where REE (resting energy expenditure) = (15.3 x Wt) +679 kcal, where weight is the weight in kilograms of the reference male military individual.

The energy standard in the 2001 Nutrition Standards and Education regulation was based on figures for moderate to heavy physical activity to provide for the extended work days and high levels of activity typical of field operations. This standard is modest considering actual energy expenditures measured by doubly-labeled water in USARIEM field studies. A study conducted with Special Forces soldiers (1) revealed an average energy requirement of 3480 kcal/d over the 30 days of the test which included many low activity days. Energy expenditures of male combat engineers during the first two weeks of deployment to Bolivia averaged 3549 kcal/d (8). Mean daily energy expenditures of representative male personnel of a Combat Support Hospital were 3956 kcal during an 11-day field training exercise (Baker-Fulco, unpublished data). Army Rangers had a daily average of almost 5200 kcal during an eight-day field training exercise (26).

Although energy requirements in field situations are often much higher than 3600 kcal, this is a practical standard for rations, given that many warfighters do not typically need as much as 3600 kcal and that most tend to have less time or inclination to eat as the intensity and duration of training increases. Raising the standard may not lead to greatly increased energy intakes and would likely lead to more food waste. When high energy expenditures are predicted, consideration should be given to providing a

special, high-calorie ration (e.g., three packets of the Meal, Cold-Weather) or providing supplemental foods and beverages.

Protein

The NSOR for protein of 91 g is based on the average protein MDRI for men to provide for individuals with typical protein needs. This value represents a nine gram decrease from the 1985 standard, which was based on an MRDA of 100 g.

Carbohydrate

The carbohydrate ration standard is 494 g. This value is derived from the distribution of the energy standard (3600 kcal) resulting from a protein standard of 91 g (364 kcal) and a fat standard of no more than 35% of total energy, which equates to 140 g fat in a 3600 kcal ration. The energy not accounted for by protein and fat is allotted to carbohydrate. This carbohydrate standard supports the Committee on Military Nutrition Research recommendation (3) for troops to consume at least 400 g of carbohydrate per day to permit a reasonable rate of glycogen resynthesis to help prevent chronic fatigue.

Fat

The NSOR for fat is now expressed as a proportion of energy content and is reduced from essentially the equivalent of a maximum of 40% of energy (160 g fat maximum) to an upper limit of 35% of energy. Restriction of fat to only 30%, as recommended for dietary intakes in the 2001 Nutrition Standards and Education regulation, is not appropriate for most military rations where energy density, ration bulk, and palatability are of particular concern. A modestly high-fat content is not a concern if most of the fat is in the form of mono-unsaturated and polyunsaturated fatty acids sufficiently protected by antioxidants. On the other hand, a 40% fat ration is higher in fat than the modern military consumer desires and limits the content of carbohydrate and protein in the ration. Carbohydrate and protein are more important for the maintenance or enhancement of health and performance (5,16).

Vitamin K

The 2001 Nutrition Standards and Education regulation set a ration standard for vitamin K for the first time. The NSOR for vitamin K is 80 μg, based on the MDRI for men.

Vitamin C

The NSOR for vitamin C is based on the higher of the gender-specific MDRIs, with no adjustment to accommodate the higher needs of smokers.

Thiamin (B_1), Riboflavin (B_2), & Niacin

The substantial decreases of the NSORs for these B vitamins reflect the change dietary intake recommendations from the 1980 RDA to the 2000 DRI. The RDAs in th 2000 DRIs and the 2001 MDRIs are no longer directly based on energy intake. Therefore, the NSORs are no longer based on the ration standard for energy. The NSORs for these vitamins are based on their respective male MDRIs as the higher value of the gender-specific MDRIs.

Vitamin B_6

The NSOR for vitamin B_6 is now 1.3 mg, down from 2.2 mg in the 1985 standards. The decrease reflects the change in the derivation of the dietary intake recommendations, which are no longer directly related to the typically generous p intakes of Americans.

Vitamin B_{12}

The NSOR for vitamin B_{12} is 2.0 μg, set at the level of the current MDRI for men and women. The decrease of 0.6 μg reflects the change in dietary intake recommendations from the 1980 RDA to the 2000 DRI.

Calcium

The NSOR for calcium is 1000 mg. This represents a 25 percent increase from the 1985 calcium ration standard. The increase was due to the change in dietary calcium recommendations from the 1980 RDA, on which the 1985 MRDA regulation was based, and the 1997 DRI for calcium, on which the 2001 MDRI for calcium is based.

Phosphorus

The NSOR for phosphorus of 700 mg is based on the MDRI for male and female personnel. The decrease from 800 mg in the 1985 NSOR is due to the change in the derivation of dietary recommendations for phosphorus, which are no longer correlated to calcium intake recommendations.

Magnesium

The NSOR for magnesium is 420 mg, which is based on the MDRI for male personnel as the higher of the gender-specific MDRIs for magnesium. This magnesium standard is 20 mg greater than the previous one.

Iron

The NSOR for iron is 15 mg, which is based on the MDRI for female personnel as the higher of the MDRIs for iron. This value is 3 mg lower than the standard presented in the 1985 regulation and reflects the decrease in the RDA for women from 1980 to 1989.

Sodium

The sodium standard remains as in the 1985 regulation, 5000–7000 mg. This value does not include sodium provided in salt packets. The 5000 mg sodium amount was derived from the lower end of the recommended sodium intake range (i.e., 1400 mg/1000 kcal) and the energy standard for operational rations (3600 kcal), rounding down to the nearest 1000 mg. Five thousand milligrams is a minimum sodium content standard. The upper end of the standard was set higher than the MDRI level to better provide for the higher sodium requirements of unacclimitized individuals working in hot environments. A higher sodium standard also allows ration planners greater flexibility in using popular, commercial products, which tend to be relatively high in sodium.

Consideration was given to only establishing a maximum content standard of 6100 mg sodium, exclusive of salt packets, based on the high end of the sodium intake recommendation (1700 mg/1000 kcal) and the energy standard for operational rations (3600 kcal). But, there were concerns a minimum sodium content standard is necessary to ensure adequate sodium provision during operational conditions and an upper limit of 6100 mg may not be generous enough for hot-weather field feeding.

Iodine

A ration standard for iodine was established for the first time in the 2001 Nutrition Standards and Education regulation. The standard of 150 μg is based on the MDRI for men and women. This level should be met through the use of iodized salt in the manufacture of operational rations, since food sources are highly variable and few foods are naturally good sources. Currently, military specifications for operational rations specifically call for the use of non-iodized salt. The rationale for this proscription is unknown. Iodization does not affect the taste of salt. Because sweat-associated iodine losses can be appreciable, it is very important that operational rations (which are designed for physically-active individuals in different environmental extremes) contain at least this conservative ration standard level.

Selenium and Fluoride

NSORs for selenium and fluoride were set for the first time in the 2001 Nutrition Standards and Education regulation. The standards (55 μg for selenium and 4 mg for fluoride) are based on the higher of the gender-specific MDRIs for each nutrient.

NUTRITIONAL STANDARDS FOR RESTRICTED RATIONS

Restricted rations are for use under certain operational scenarios in which it is necessary for troops to subsist for short periods on nutritionally-inadequate rations. Such scenarios include long-range patrol, assault and reconnaissance, and other situations where resupply is tactically unfeasible. Restricted rations are designed to only provide the minimal amounts of nutrients needed to maintain body functions and prevent rapid depletion of body stores. Healthy personnel can subsist for short periods (up to 10 days) on restricted rations with usually no more than minor decrements in performance or nutritional status.

Table 4 on page 17 presents the Nutritional Standards for Restricted Rations. Except as noted below, the restricted ration standards are arbitrarily set at 50 percent of the respective standards for operational rations, rounding up to the same number of digits used to express the NSOR. This follows the precedent set for the establishment of restricted ration standards presented in past regulations.

Energy

The energy standard of 1500 kcal is set at the upper level specified in the 1985 standard for restricted rations. Setting the energy standard at 1800 kcal (50% NSOR) would necessitate an increase in weight and size of a restricted ration to unacceptable limits. Resting energy needs of most personnel would be met by 1500 kcal. Although a 1500 kcal diet could produce substantial weight loss, there is no evidence that performance or health is compromised over a short term (10 days or less), as long as fluid and electrolyte requirements are met (17).

Protein

The restricted ration standard for protein is based on 50% of the NSOR, rounding up to the nearest 10 grams.

Carbohydrate

The restricted ration standard for carbohydrate is 200 g. This amount is sufficient to minimize ketosis. It was felt that increasing the carbohydrate standard to 50% of the carbohydrate NSOR would negatively affect the bulk and weight of a restricted ration.

Fat

There is no restricted ration standard for fat. However, fat content should not normally exceed 35% of total calories.

Vitamin B_6

The restricted ration standard was set at 50% of the NSOR for vitamin B_6. The apparent discrepancy is the result of rounding.

Sodium

The restricted ration standard for sodium is 2500–3500 mg, not including the sodium in salt packets, and was based on 50 percent of the NSOR for sodium. This amount of sodium may be inadequate for some military personnel operating in and not yet acclimatized to hot environments. In these situations, it would be appropriate to provide a supplemental electrolyte beverage to replace lost electrolytes. A higher sodium content in the ration would require higher intakes of water, which may not be available in the operational setting in which the restricted ration is being used.

Potassium

The restricted ration standard for potassium of 2000 mg is based on the estimated daily adult minimum requirement presented in the 10th edition of the RDA (21).

REFERENCES

1. Askew, E. W., I. Munro, M. A. Sharp, S. Siegel, R. Popper, M. S. Rose, R. W. Hoyt, J. W. Martin, K. Reynolds, H. R. Lieberman, D. Engell, and C. P. Shaw. *Nutritional status and physical and mental performance of special operations soldiers consuming the Ration, Lightweight or the Meal, Ready-to-Eat military field ration during a 30-day field training exercise.* Natick, MA: USARIEM. Technical Report T7-87, 1987.

2. Burgess, E., R. Lewanczuk, P. Bolli, A. Chockalingam, H. Cutler, G. Taylor, P. Hamlet. Lifestyle modifications to prevent and control hypertension. 6. Recommendations on potassium, magnesium and calcium. Canadian Hypertension Society, Canadian Coalition for High Blood Pressure Prevention and Control, Laboratory Centre for Disease Control at Health Canada, Heart and Stroke Foundation of Canada. *Can. Med. Assoc. J.* 160 (9 Suppl): S35-S45, 1999.

3. Committee on Military Nutrition Research. *Report of Committee Activities, October 1, 1986 - September 30, 1987.* Washington, D.C.: National Academy Press, 1988.

4. Committee on Military Nutrition Research. *Military Nutrition Initiatives.* Washington, D.C: Institute of Medicine Publication IOM-91-05, February 25, 1991.

5. Committee on Military Nutrition Research. *The Role of Protein and Amino Acids in Sustaining and Enhancing Performance.* Washington, D.C.: National Academy Press, 1999.

6. Department of the Army, Headquarters. *Nutrition Standards, Allowances, and Education.* Washington, D.C. AR 40-25/NAVMEDCOMINST 10110.1/AFR160-95, 1985.

7. Department of the Army, Headquarters. *Nutrition Standards and Education.* Washington, D.C. AR 40-25/NAVMEDCOMINST 10110.1/AFI 44-141, *DATE***. 2001.

8. Edwards, J. S. A., E. W. Askew, N. King, C. S. Fulco, R. W. Hoyt, and J. P. DeLany. *An assessment of the nutritional intake and energy expenditure of unacclimatized U.S. Army soldiers living and working at high altitude.* Natick, MA: USARIEM. Technical Report T10-91, 1991.

9. Gordon, C. U.S. *Army Anthropometric Survey Database: Downsizing, demographic change, and validity of the 1988 data in 1996.* Natick, MA: U.S. Army Natick RD&E Center. Technical Report T-97/003, 1996.

10. Holick, M. F. Cholecalciferol and Ergocalciferol. In: *Encyclopedia of Human Nutrition,* edited by M. J. Sadler, J. J. Strain, and B. Caballero. San Diego, CA: Academic Press, 1999, pp. 357–370.

11. Institute of Medicine. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride.* Washington, D.C.: National Academy Press, 1997.

12. Institute of Medicine. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline.* Washington, D.C.: National Academy Press, 1998.

13. Institute of Medicine. *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids.* Washington, D.C.: National Academy Press, 2000.

14. Lemon, P. W. Effect of exercise on protein requirements. *J. Sports Sci,* 9 Spec No: 53-70, 1991.

15. Luft, F. C. Potassium and its regulation. In: *Present Knowledge in Nutrition. 7th ed.,* edited by E.E. Ziegler and L. J. Filer, Jr. Washington, D.C.: ILSI Press, 1996, pp. 272-276.

16. Marriott, B. M. ed. *Food Components to Enhance Performance.* Washington, D.C.: National Academy Press, 1994.

17. Marriott, B. M. ed. *Not Eating Enough: Overcoming Underconsumption of Military Operational Rations.* Washington, D.C.: National Academy Press, 1995.

18. National Heart, Lung, and Blood Institute. *The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.* NIH Publication No. 98-4080, 1997.

19. National Research Council, *Recommended Dietary Allowances, 9th ed. Report of the Committee on Dietary Allowances, Food and Nutrition Board, Division of Biological Sciences, Assembly of Life Sciences.* Washington, D.C: National Academy of Sciences, 1980.

20. National Research Council. *Diet and Health: Implications for Reducing Chronic Disease Risk. Report of the Committee on Diet and Health, Food and Nutrition Board, Commission on Life Sciences.* Washington, D.C: National Academy Press, 1989.

21. National Research Council. *Recommended dietary Allowances, 10th ed. Report of the Subcommittee on the Tenth Edition of the RDAs, Food and Nutrition Board, Commission on Life Sciences.* Washington, D.C.: National Academy Press, 1989.

22. Paul, G. Dietary protein requirements of physically-active individuals. *Sports Med.* 8:154-176, 1989.

23. Shaw, A., L. Fulton, C. Davis, and M. Hogbin. *Using the Food Guide Pyramid: A Resource for Nutrition Educators* [online] U.S. Department of Agriculture, undated. http://www.nal.usda.gov.fnic/Fpyr/guide.pdf [September 29, 2000].

24. Stamler, J., G. Rose, R. Stamler, P. Elliott, A. Dyer, and M. Marmot. INTERSALT Study findings: Public health and medical care implications. *Hypertension* 14: 570-577, 1989.

25. Tarnopolsky, M. Protein, caffeine, and sports. Guidelines for active people. *Physician and Sportsmed.* 21:137-149, 1993.

26. Tharion, W. J., J. P. Warber, R. W. Hoyt, and J. P. DeLany. Energy requirements of Rangers in garrison vs. in the field. *FASEB J.* 12: A204, 1998.

27. U.S. Department of Agriculture. *The Food Guide Pyramid.* Home and Garden Bulletin No. 252. Washington, D.C.: U.S. Government Printing Office, 1996.

28. U.S. Department of Agriculture and Department of Health and Human Services. *Nutrition and Your Health: Dietary Guidelines for Americans.* Home and Garden Bulletin No. 232. Washington, D.C.: U.S. Government Printing Office, 1980.

29. U.S. Department of Agriculture and Department of Health and Human Services. *Nutrition and Your Health: Dietary Guidelines for Americans. 5th ed.* Home and Garden Bulletin No. 232. Washington, D.C.: U.S. Government Printing Office, 2000.

30. Williams, C. Macronutrients and performance. *J. Sports Sci.* 13: S1-S10, 1995.

APPENDIX

Documentation Tables

Table A-1. Data considered when establishing the MDRI for MALE personnel.

		RDA (1989)			DRI (1997–1999)			MRDA	**MDRI**
Age Group		17-18 yr	19-24 yr	25-50 yr	17-18 yr	19-30 yr	31-50 yr	(1985)	**(2001)**
% Active-duty Men		[3%]	[34%]	[62%]	[3%]	[59%]	[37%]		
Nutrient	*Unit*								
Vitamin A	µg RE	**1000**	**1000**	**1000**				1000	**1000**
Vitamin D	µg	10	10	5	(AI) **5**	(AI) **5**	(AI) **5**	5.0 to 10	**5**
Vitamin E	Varies*	10 mg α-TE	10 mg α-TE	10 mg α-TE	(RDA) **15 mg**	(RDA) **15 mg**	(RDA) **15 mg**	10 mg α-TE	**15 mg**
Vitamin K	µg	65	70	**80**				(ESADDI) 70-140	**80**
Vitamin C	mg	60	60	60	(RDA) 75	(RDA) **90**	(RDA) **90**	60	**90**
Thiamin (B_1)	mg	1.5	1.5	1.5	(RDA) 1.2	(RDA) **1.2**	(RDA) **1.2**	1.6	**1.2**
Riboflavin (B_2)	mg	1.8	1.7	1.7	(RDA) 1.3	(RDA) **1.3**	(RDA) **1.3**	1.9	**1.3**
Niacin	mg NE	20	19	19	(RDA) **16**	(RDA) **16**	(RDA) **16**	21	**16**
Vitamin B_6	mg	2	2	2	(RDA) **1.3**	(RDA) **1.3**	(RDA) **1.3**	2.2	**1.3**
Folate	µg	200	200	200	(RDA) **400**	(RDA) **400**	(RDA) **400**	400	**400**
Vitamin B_{12}	µg	2	2	2	(RDA) **2.4**	(RDA) **2.4**	(RDA) **2.4**	3.0	**2.4**
Calcium	mg	1200	1200	800	(AI) 1300	(AI) **1000**	(AI) **1000**	800 to 1200	**1000**
Phosphorous	mg	1200	1200	800	(RDA) 1250	(RDA) **700**	(RDA) **700**	800 to 1200	**700**
Magnesium	mg	400	350	350	(RDA) 410	(RDA) 400	(RDA) **420**	350 to 400	**420**
Iron	mg	12	**10**	**10**				10 to 18	10
Zinc	mg	**15**	**15**	**15**				15	**15**
Sodium	mg		(EMR) 500	(EMR) 500				5500	**5000** (4550-5525)
Iodine	µg	**150**	**150**	**150**				150	**150**
Selenium	µg	50	70	70	(RDA) **55**	(RDA) **55**	(RDA) **55**	(ESADDI) 50-200	**55**
Fluoride	mg	(ESADDI) 1.5-2.5	(ESADDI) 1.5-4	(ESADDI) 1.5-4	(AI) 3	(AI) **4**	(AI) **4**	(ESADDI) 1.5-4.0	**4**
Potassium	mg	(EMR) 2340	(EMR) 2000	(EMR) 2000				(ESADDI) 1875-	**3200**

NOTES: A bolded RDA or DRI value indicates the value used to establish the MDRI. MDRI values which are bolded are the values used to establish the Nutrition Standard for Operational Rations, see Table 4. RDA, Recommended Dietary Allowance; DRI, Dietary Reference Intake; MRDA, Military Recommended Dietary Allowance; MDRI, Military Dietary Reference Intake; µg RE, microgram Retinol Equivalent; AI, Adequate Intake; α-TE, alpha tocopherol equivalent; NE, Niacin Equivalent; ESADDI, Estimated Safe and Adequate Daily Dietary Intake; EMR,Estimated minimum requirement. *DRI for vitamin E based on only alpha-tocopherol.

Table A-2. Data considered when establishing the MDRI for FEMALE personnel.

		RDA (1989)			DRI (1997–1999)			MRDA (1985)	**MDRI (2001)**
Age group		15-18 yr	19-24 yr	25-50 yr	14-18 yr	19-30 yr	31-50 yr		
% Active-duty Women		[4%]	[38%]	[56 %]	[4%]	[63%]	[31%]		
Nutrient	*Unit*								
Vitamin A	µg RE	**800**	**800**	**800**				800	800
Vitamin D	µg	10	10	5	(AI) **5**	(AI) **5**	(AI) **5**	5.0 to 10	**5**
Vitamin E	varies*	8 mg α-TE	8 mg α-TE	8 mg α-TE	(RDA) **15 mg**	(RDA) **15 mg**	(RDA) **15 mg**	8 mg α-TE	**15** mg
Vitamin K	µg	55	60	**65**				(ESADDI) 70-140	65
Vitamin C	mg	60	60	60	(RDA) 65	(RDA) **75**	(RDA) **75**	60	75
Thiamin (B_1)	mg	1.1	1.1	1.1	(RDA) 1	(RDA) **1.1**	(RDA) **1.1**	1.2	1.1
Riboflavin (B_2)	mg	1.3	1.3	1.3	(RDA) 1	(RDA) **1.1**	(RDA) **1.1**	1.4	1.1
Niacin	mg NE	15	15	15	(RDA) **14**	(RDA) **14**	(RDA) **14**	16	14
Vitamin B_6	mg	1.5	1.6	1.6	(RDA) 1.2	(RDA) **1.3**	(RDA) **1.3**	2.0	**1.3**
Folate	µg	180	180	180	(RDA) **400**	(RDA) **400**	(RDA) **400**	400	**400**
Vitamin B_{12}	µg	2.0	2.0	2.0	(RDA) **2.4**	(RDA) **2.4**	(RDA) **2.4**	3.0	**2.4**
Calcium	mg	1200	1200	800	(AI)1300	(AI)**1000**	(AI)**1000**	800-1200	**1000**
Phosphorous	mg	1200	1200	800	(RDA) 1250	(RDA) **700**	(RDA) **700**	800-1200	**700**
Magnesium	mg	300	280	280	(RDA) 360	(RDA) 310	(RDA) **320**	300	320
Iron	mg	**15**	**15**	**15**				18	**15**
Zinc	mg	**12**	**12**	**12**				15	12
Sodium	mg		(EMR) 500	(EMR) 500				4100	3600 (3220-3910)
Iodine	µg	**150**	**150**	**150**				(ESADDI) 150	**150**
Selenium	µg	50	55	55	(RDA) **55**	(RDA) **55**	(RDA) **55**	(ESADDI) 50-200	55
Fluoride	mg	(ESADDI) 1.5-2.5	(ESADDI) 1.5-4	(ESADDI) 1.5-4	(AI) 2.9	(AI) **3.1**	(AI) **3.1**	(ESADDI) 1.5-4.0	3.1
Potassium	mg	1700	(EMR) 2000	(EMR) 2000				(ESADDI) 1875-5625	2500

NOTES: A bolded RDA or DRI value indicates the value used to establish the MDRI. MDRI values which are bolded are the values used to establish the Nutrition Standard for Operational Rations, see Table 4. RDA, Recommended Dietary Allowance; DRI, Dietary Reference Intake; MRDA, Military Recommended Dietary Allowance; MDRI, Military Dietary Reference Intake; µg RE, microgram Retinol Equivalent; AI, Adequate Intake; α-TE, alpha tocopherol equivalent; NE, Niacin Equivalent; ESADDI, Estimated Safe and Adequate Daily Dietary Intake; EMR,Estimated minimum requirement. *DRI for vitamin E based on only alpha-tocopherol.

Table A-3. Dietary Reference Intakes released after the Nutrition Standards and Education Regulation was drafted.

		MALE				FEMALE			
		DRI			MDRI (2001)	DRI			MDRI (2001)
Age group		14-18 yr	19-30 yr	31-50 yr		14-18 yr	19-30 yr	31-50 yr	
Nutrient	*DRI Type*								
Vitamin A	RDA	900 µg RAE	900 µg RAE	900 µg RAE	1000 µg RE	700 µg RAE	700 µg RAE	700 µg RAE	800 µg RE
Vitamin K	AI	75 µg	120 µg	120µg	80 µg	75 µg	90µg	90 µg	65 µg
Chromium	AI	35 µg	35 µg	35 µg	--	24 µg	25µg	25 µg	--
Copper	RDA	890 µg	900 µg	900µg	--	890 µg	900 µg	900 µg	--
Iodine	RDA	150 µg	150 µg	150 µg	150 µg	150 µg	150 µg	150 µg	150 µg
Iron	RDA	11 mg	8 mg	8 mg	10 mg	15 mg	18mg	18 mg	15 mg
Manganese	AI	2.2 mg	2.3 mg	2.3 mg	--	1.6 mg	1.8 mg	1.8 mg	--
Molybdenum	RDA	43 µg	45 µg	45 µg	--	43µg	45 µg	45 µg	--
Zinc	RDA	11 mg	11 mg	11 mg	15 mg	9 mg	8 mg	8 mg	12 mg

NOTES: RAE, Retinol activity equivalent . One RAE is equal to 1 µg all-*trans*-retinol, 12 µg β-carotene and 24 µg α-carotene and β-cryptoxanthin. The RAE for provitamin A carotenoids is two-fold higher than the bioconversion factor used for retinal equivalents (RE), a change that means that twice as much provitamin A-rich carotenoids contained in green leafy vegetables and certain fruits are required to provide a given amount of vitamin A. In the 1989 RDA publication, 6 µg β-carotene or 12 µg other provitamin A caroteoids were defined as one retinol equivalent.

RDA, Recommended Dietary Allowance. The intake that meets the nutrient need of almost all (97%–98%) of individuals in a group.

AI, Adequate Intake. The observed average or experimentally determined intake by a defined population or subgroup that appears to sustain a defined nutritional status. AI is used if sufficient scientific evidence is not available to derive an estimated average requirement.

SOURCE: Institute of Medicine. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc [PrePublication copy online]*. National Academy Press. copyright 2000, The National Academy of Sciences. [January 23, 2001].

GLOSSARY

Adequate Diet: A diet that provides all of the essential nutrients and calories in quantities sufficient to maintain good health and ideal body weight.

Adequate Intake: An Adequate Intake (AI) is the observed or experimentally set intake by a defined population or subgroup that appears to sustain a defined nutritional status, such as growth rate, normal circulating nutrient values, or other functional indicators of health. AI is utilized if sufficient scientific evidence is not available to derive an estimated average requirement (EAR), which is needed to establish an RDA. The AI is not equivalent to an RDA.

α-tocopherol: The active form of vitamin E.

α-tocopherol Equivalent (TE): Historical unit of measure for vitamin E.

Ascorbic acid: Vitamin C. Needed for maintenance of bones, teeth, and tendons; wound healing; and protection against infection. Promotes iron absorption. Found in fruits and vegetables.

β-carotene: A precursor of vitamin A found in plants; an orange pigment.

Biotin: One of the B vitamins; participates in the building of fatty acids. Widespread in many foods, especially vegetables, legumes, meats, whole grains, fruits, and milk.

Calcium: The most abundant mineral in the body; necessary for bone structure, nerve and muscle function, blood clotting, and normal functioning of heart muscle. Found in dairy products, green leafy vegetables, shellfish, dried beans, and seeds.

Calorie: A measure of heat energy. A calorie is the amount of heat needed to raise the temperature of one cubic centimeter of water one degree Celsius. The word "calorie" with a lower-case "c" is to be distinguished from "Calorie" with a capital "C" or "kilocalorie," both of which are equal to 1000 "calories" and conventionally used to indicate energy content of food.

Carbohydrate: A group of compounds composed of carbon, hydrogen, and oxygen arranged as a single sugar unit or multiple sugar units. Glucose, glycogen, sugar, starches, fiber, and cellulose are all carbohydrates. Except for dietary fiber, to include cellulose, carbohydrates provide approximately 4 kilocalories per gram.

Carotene: The vitamin A precursor abundant in yellow vegetables.

Cholecalciferol: Vitamin D_3; a natural substance occurring in animal cells and formed by the action of sunlight on a cholesterol derivative in the skin. See vitamin D.

Cholesterol: A fat-like substance present in all animal foods. Dietary cholesterol, to a lesser extent than saturated fats, raises blood cholesterol levels in many individuals, increasing their risk for heart disease.

Chromium: An essential mineral involved in regulation of blood sugar levels. Food sources include peanuts, prunes, oils, various vegetables, whole-wheat bread, and chicken.

Complex Carbohydrate: Many (ten or more) single sugar units chemically linked together. Starch, glycogen, and most dietary fibers. A term used to describe a food high in starch or fiber, such as bread, cereals, fruits and vegetables, as contrasted to simple carbohydrates, such as table sugar.

Copper: Mineral part of several enzyme systems. Found in seeds and nuts, seafood, dried fruits, legumes, and whole-grain cereals.

Dietary Reference Intakes (DRI): Nutrient reference values, established by the Food and Nutrition Board of the Institute of Medicine, that are quantitative estimates of nutrient intake to be used for planning for and assessing diets of healthy persons. They are designed to reflect the latest understanding about nutrient requirements and prevention of chronic disease. DRIs include recommended dietary allowances (RDAs), adequate intakes (AIs), estimated average requirements (EARs), and tolerable upper intake levels (UL).

Electrolytes: Compounds that partly dissociate in water to form ions. The electrolytes sodium, potassium, and chloride maintain the fluid integrity of each compartment of the body.

Fats: Organic compounds that serve as a source of energy and are used by the body to make cell membranes and regulating chemicals. Fats have a high energy value, yielding about 9 kilocalories per gram, compared with 4 kilocalories per gram for carbohydrate and protein. *Saturated fats* have no double bonds, are generally hard at room temperature, and have been associated with increased risk of heart disease. *Monounsaturated fats* and *polyunsaturated fats* have one or more double bonds, respectively, are generally liquid at room temperature, and have been associated with decreased risk of heart disease.

Fluoride: Element beneficial to tooth and bone health. Fluoridated drinking water is the most reliable source.

Folate: One of the B vitamins; also known as folic acid. Essential in preventing certain types of anemia. Reduces risk of heart disease. Good sources of folate include enriched breads, cereals, and rice, green leafy vegetables, dry beans, and citrus fruits and their juices.

Glycogen: A multi-sugar compound composed of glucose, manufactured in the body and stored in liver and muscle; chief storage form of carbohydrate in the human body.

Gram (g): Unit of measure for mass equal to 0.035 ounces. A gram is the weight of a cubic centimeter or milliliter of water under defined conditions of temperature and pressure.

Health: The state of complete physical, mental, and social well-being.

Iron: One of the major minerals and an important component of hemoglobin (the oxygen-carrying protein of blood), myoglobin (a muscle protein molecule that binds oxygen), and a number of enzyme systems. Lean meats, fish, and seafood are good sources. Many plant foods, such as green vegetables, seeds and nuts, dried fruits, and legumes and fortified breakfast cereals, are also significant sources of iron.

Iodine: Mineral important in thyroid function. Best source is iodized salt.

Kilocalorie (Kcal): A unit of measure for energy used to describe the amount of energy released by foods. One thousand calories. The amount of heat necessary to raise the temperature of a kilogram (liter) of water 1 degree Celsius. Both carbohydrate and protein provide approximately 4 kcal per gram, fat provides approximately 9 kcal per gram, and alcohol provides approximately 7 kcal per gram.

Kilogram (Kg): A unit of measure for mass in the metric system. Equal to 1000 grams or 2.2 pounds.

Macronutrients: Carbohydrates, proteins, and fats. Essential to human health in relatively large amounts, when compared to the micronutrients (minerals and vitamins).

Magnesium: Major mineral required for more than 300 different enzyme systems. The use and storage of carbohydrate, fat, and protein in the body involve many reactions that are magnesium-dependent. Also essential in nerve and muscle activity. Good sources are seeds and nuts, whole-grain cereals, dark green vegetables, legumes, and dried fruits.

Manganese: Mineral that is part of a number of enzyme systems. Important for reproduction, bone development, and proper functioning of the brain and spinal cord. Nuts and seeds, whole grains, and various fruits and vegetables are good sources. Very little is present in animal products.

Microgram (μg): One-millionth (1/1,000,000) of a gram or one-thousandth (1/1000) of a milligram.

Military Dietary Reference Intakes(MDRIs): Nutrient recommendations, first presented in the 2001 Nutrition Standards and Education regulation, that are quantitative estimates of nutrient intake to be used for planning and assessing diets for healthy military personnel. They are based on the DRIs as well as some of the 1989 RDAs established by the Food and Nutrition Board of the Institute of Medicine.

Military Recommended Dietary Allowance (MRDA): Nutrient intake recommendations used prior to 2001 that were the levels of intake of essential nutrients considered to be adequate to meet the known nutritional needs of practically all healthy military persons.

Milligram (mg): One thousandth (1/1000) of a gram.

Mineral: A naturally-occurring, inorganic, homogeneous substance; an element.

Neutrophil: A white blood cell involved in fighting infections.

Niacin: One of the B vitamins important in several enzyme systems involved in processes in cells that release energy from carbohydrate, protein, and fat. Essential for growth, energy production, and hormone synthesis. Active forms include nicotinic acid, nicotinamide, or niacinamide. Good sources include lean meats, poultry, fish, nuts, whole grains, and enriched cereal products.

Nutrient: A substance obtained from food that provides energy, promotes growth and repair of tissues, or regulates metabolism.

Operational Ration: A specially-designed, nutritionally-adequate ration normally composed of semi-perishable or non-perishable items for use under actual or simulated combat conditions. This type of ration is used in peacetime for training, travel, contingencies, or emergencies. Operational rations include the Meal, Ready-to-Eat (MRE), the B-ration and Unitized Group Rations (UGR: A, B, or Heat and Serve).

Pantothenic Acid: A B vitamin; part of an enzyme essential to fat, carbohydrate, and protein metabolism. Found in legumes, nuts, many vegetables, poultry, dried fruits, whole grains, yogurt, and many fresh fruits.

Phosphorus: An essential nonmetallic element; teams up with calcium in forming bones and teeth. Involved in the metabolism of carbohydrates, protein, and fats. Found in many diary products, cereals, and meats.

Potassium: An essential metallic element. It is the principal positive ion inside body cells. Found widely in fruits and vegetables and nuts.

Protein: Any one of a group of complex organic compounds formed from amino acids linked in a chain, usually about 300 units long. The amino acids are essential for growth and repair of living tissues and hormone synthesis. Protein provides approximately 4 kcal per gram.

Recommended Dietary Allowance (RDA) of the Dietary Reference Intakes: Average daily dietary intake level that is sufficient to meet the nutrient requirement of nearly all (97 to 98 percent) healthy individuals in a particular life stage and gender group. The RDA is the intake at which the risk of inadequacy to an individual is very small—only 2% to 3%. The RDA is intended for use a goal for daily intake by individuals.

Recommended Dietary Allowances (RDA), past definition: Levels of average intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons. Prior to 1997, the RDAs were most appropriately applied to groups; although individual intakes, if averaged over a sufficient length of time, could be used to estimate the probable risk of deficiency for that individual.

Reference Body Weights: Body weights that represent the 50th percentile for weight of military men (79 kg) and women (62 kg). References weights are used to estimate energy, protein, and other nutrient reference values that are computed on a per kilogram body weight basis.

Resting Energy Expenditure (REE): Resting metabolic rate. This represents the energy expended by the body to maintain life and normal body functions, such as respiration and circulation.

Restricted Ration: A lightweight ration requiring no food preparation other than rehydration. Intended for short-range patrols when ration weight and space restrictions override nutritional considerations. Provides sub-optimal levels of energy (approximately 1500 kcal) and nutrients, and is intended for only short periods of use (no more than 10 days).

Retinol: Active preformed vitamin A found in animal foods, especially liver, egg yolk, milk, cheese, and fish.

Retinol Equivalent (RE): A measure of vitamin A activity. The amount of retinol that the body will derive from a food containing vitamin A (preformed retinol) or one of its precursors (β-carotene and other carotenoids). 1 RE is defined as 1 μg of all-*trans* retinol, 6 μg of all-*trans* β-carotene, or 12 μg of other provitamin A carotenoids. One International Unit (IU) of vitamin A activity has been defined as equal either to 0.30 μg of all-*trans* retinol or to 0.60 μg of all-*trans* β-carotene.

Riboflavin: Vitamin B_2; component of two vital enzyme systems that help release energy from food. The most abundant sources are milk and milk products.

Saturated Fats: Fats that have all chemical bonds filled. Raises blood cholesterol in many individuals, increasing their risk for heart disease. Found in large amounts in meat and dairy products, and in some vegetables such as coconut, palm, and palm kernel oils.

Selenium: An essential nonmetallic element resembling sulfur that is part of a red blood cell enzyme that helps to destroy chemicals that damage cell membranes. Seafood, nuts, dairy products, and whole-wheat products contain good amounts of selenium.

Simple Carbohydrates: The sugars glucose, fructose, galactose, maltose, lactose and sucrose.

Sodium: An essential metallic element; the major positive ion in the body. Sodium chloride or table salt is 40% sodium and 60% chloride.

Stereoisomers: Compounds that are identical in composition but differ in the spatial arrangement of the atoms in the molecule.

Thiamin: Vitamin B_1. Needed to release energy from carbohydrates and for nerve and heart function. Best sources include seeds and nuts, lean pork, whole and enriched grains, legumes, wheat germ and fish.

Tryptophan: An amino acid essential for humans, convertible to niacin in the body if not needed for protein synthesis.

Vitamin A: A fat-soluble vitamin required for normal vision, reproduction and fetal development, and immune function. Includes retinal, which is preformed vitamin A, and the provitamin A carotenoids that are dietary precursors of retinol. Preformed vitamin A is abundant in animal derived foods, while provitamin A carotenoids are abundant in darkly colored fruits and vegetables.

Vitamin B_6: One of the B vitamins; required for protein metabolism. Active forms include pyridoxal, pyridoxine, and pyridoxamine. Good sources are legumes, dried fruit, seeds and nuts, bananas, rice, and many vegetables

Vitamin B_{12}: One of the B vitamins, also known as cobalamin. Found only in foods of animal origin.

Vitamin C: See ascorbic acid.

Vitamin D: Needed for bone growth and regulation of blood calcium and phosphorus levels. Vitamin D occurs in two major forms: vitamin D_2 (ergocalciferol) and vitamin D_3 (cholecalciferol). Best source is vitamin D fortified dairy products.

Vitamin Deficiency: Below-normal body vitamin levels due to inadequate intake or absorption; specific disorders occur dependent upon the deficient vitamin.

Vitamin E: An antioxidant vitamin; protects cell membranes. The active form of vitamin E is α-tocopherol. All other forms are no longer considered bioactive. Best source is vegetable oils. Margarine, whole grains, dark-green, leafy vegetables, nuts, seeds, and legumes are also sources.

Vitamin K: Vitamin essential for the production of several protein factors involved in the clotting process. The richest sources are dark green and deep yellow vegetables.

Zinc: An essential, metallic element, part of more than 70 major enzyme systems which control growth, sexual maturation, would healing, and the maintenance of skin, hair, nails, and mucous membranes of the mouth, throat, stomach, and intestines. Good sources are seeds and nuts, legumes, whole-grain cereals, dairy products, and lean meats.